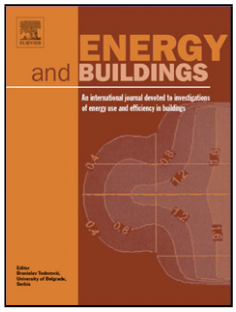

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Authors: M. Zinzi, E. Carnielo

PII: S0378-7788(17)31641-9
DOI: http://dx.doi.org/doi:10.1016/j.enbuild.2017.05.021
Reference: ENB 7602

To appear in: *ENB*

Received date: 7-10-2016
Revised date: 28-4-2017
Accepted date: 9-5-2017

Please cite this article as: M.Zinzi, E.Carnielo, Impact of urban temperatures on energy performance and thermal comfort in residential buildings.The case of Rome, Italy, Energy and Buildingshttp://dx.doi.org/10.1016/j.enbuild.2017.05.021

Impact of urban temperatures on energy performance and thermal comfort in residential buildings. The case of Rome, Italy.

Zinzi M.[1], Carnielo E.[2]

[1] Michele Zinzi, ENEA, Energy Efficiency in Building Unit, Rome, Italy, michele.zinzi@enea.it

[2] Emiliano Carnielo, Roma TRE University, Engineering Department, Rome, Italy, emiliano.carnielo@uniroma3.it

Average air temperatures in the Mediterranean region are in the thermal comfort zone for human beings in summer. However, irradiation conditions, construction technologies and subjective comfort expectations are dramatically increasing the cooling demand in buildings, exacerbated by the ambient temperature increase due to the climate change and the urban heat island phenomenon. This paper investigates the impact of the urban environment on the energy and thermal response of residential buildings, considering the case of the city of Rome, Italy. Ambient air temperature and relative humidity were continuously measured in four neighborhoods in 2015 and 2016. The monitored neighborhoods are characterized by: location in the urban area; construction materials for buildings and pavements; geometry of the urban texture. Data were also measured by a non-urban station, used as undisturbed reference. The climatic data were then used to calculate the thermal response of a typical Italian residential building, ideally located in the monitored areas of the city. Two envelope configurations were taken into account: with and without thermal insulation. Heat island intensities up to 8 °C was detected, with maximum monthly averages equal to 2 °C. The urban heat island increases the building cooling energy needs by 12% in the peripheral neighborhood and by up to 46% in the city center, respect to the undisturbed zone. For not cooled buildings, it was found out that the number of hours of thermal discomfort remains significant in urban buildings, despite the application of night ventilation strategies, while comfort conditions are mostly reached for buildings in the countryside.

KeyWords: Energy performance of buildings; urban temperatures; thermal comfort; urban heat island.

1. INTRODUCTION

Global warming and the associate climate changes are serious issues at planetary level, as observed and predicted since many years [1]. Southern Europe and the whole Mediterranean region are a fragile system with risks of air temperature rise well above 2 °C, with respect to 1990 yearly average, without the adoption of effective mitigation policies [2]. Another major issue is the continuous urban sprawl [3]. The population living in urban area accounts for 75 % of the total in the European Union and for 60 % in the Middle East and North African countries, the latter characterized by an impressive growth during the past decades.

The urban sprawl contributed to an impressive increase in the intensity of the Urban Heat Island (UHI) effect, which is defined as the increase of the air temperature in urban areas compared to that in the countryside. The phenomenon was firstly measured in London in the first half of the 19th century [4] and it has been thoroughly analyzed in the last three decades. Many studies extensively document the phenomenon as reported in [5], however some aspects are still in need of a better understanding [6]. Modelling and experimental analyses prove that the magnitude of urban ambient temperature is a function of several factors: morphological and geometrical characteristics of the urban fabric, thermal and radiative response of the construction materials, physical characteristic of the territorial context, local climatic conditions, presence or lack of green areas and heat released by buildings and vehicles. The consequence is that an urban area is characterized by a specific thermal response for each land-cover and land-use class (LCLU) [7]. Moreover, beside a spatial dependency of the UHI in assigned urban areas, the phenomenon can significantly change during the day (daytime and night-time UHIs) and depending on the season (winter